

Notice of Allowability

Application No.

10/614,700

Examiner

Geoffrey Mruk

Applicant(s)

XIN-SHAN ET AL.

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☐ This communication is responsive to ____.
2. ☒ The allowed claim(s) is/are 1-9.
3. ☒ The drawings filed on 6 January 2004 are accepted by the Examiner.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some* c) ☐ None of the:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
- (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
- 1) ☐ hereto or 2) ☐ to Paper No./Mail Date ____.
- (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date 8 July 2003
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date ____.
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other ____.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee. Authorization for this examiner's amendment was given in a telephone interview with Kelly Hyndman on 10/21/2004.

The title has been rewritten as follows:

Piezoelectric Liquid-Jet Head Having a Superconductor Layer

The abstract has been rewritten as follows:

A piezoelectric liquid-jet head apparatus, which provides a nearly uniform piezoelectric element and enables ejection of liquid at maximum output, is disclosed. The piezoelectric liquid-jet head has a piezoelectric element 300 provided on one surface of a passage forming substrate 10 via a vibration plate. The piezoelectric liquid jet head includes: a zirconium oxide layer 101 formed on the surface of the passage forming substrate 10; a cerium oxide layer 102 formed on the zirconium oxide layer 101; a superconductor layer 103 formed on the cerium oxide layer 102 and composed of a yttrium-barium-copper-oxygen-based material (YBCO); a lower electrode 60 formed on the superconductor layer 103 and composed of strontium ruthenate; and a piezoelectric layer 70 which is a single crystal epitaxially grown on the lower electrode 60.

The following is an examiner's statement of reasons for allowance:

The present invention claims a structure for a liquid-jet head made of a zirconium oxide layer formed on one surface of a passage-forming substrate; a cerium oxide layer formed on said zirconium oxide layer; a superconductor layer formed on said cerium oxide layer and composed of a yttrium-barium-copper-oxygen-based material (YBCO); wherein a lower electrode is formed on said superconductor layer and composed of strontium ruthenate; and a piezoelectric layer is formed on said lower electrode. These features and layer combinations are not present in prior art of record.

United States patent number 6,142,615 to Qiu et al., teach an ink-jet recording head with a piezoelectric device. "It is preferable that the piezoelectric device have an upper electrode and a lower electrode, which serves as a base for crystal growth, and that a piezoelectric layer that is closely attached to the lower electrode have a crystal particle that serves as the nucleus for the crystal growth. This is because when a crystal particle exists in the piezoelectric layer that is closely attached to the lower electrode, the crystal growth begins at the particle, and a piezoelectric layer having a preferable crystal condition can be formed" (Column 3, lines 49-57). However, Qiu et al. does not disclose using a 3 layer structure comprising: a zirconium oxide layer formed on the passage-forming substrate; a cerium oxide layer formed on said zirconium oxide layer; and a superconductor layer formed on said cerium oxide layer and composed of a yttrium-barium-copper-oxygen-based material (YBCO); a lower electrode formed on said superconductor layer, to support a piezoelectric element.

United States patent number 6,511,161 to Sumi et al. discloses an inkjet type recording head using a piezoelectric thin film component. This piezoelectric thin film component provides a mechanism to reduce the influence of residual strain. Sumi et al. states that "foreign substances decreases residual strain" and "decreasing the width of the crystal grain boundary of the piezoelectric thin film leads to control of the crystal grain boundaries themselves, which are the source of cavities, which cause residual strain" (Column 3, lines 29-34). Sumi et al. teaches that the reduction of the foreign substances is achieved by crystallization where "It is preferable that crystal grains of the piezoelectric thin film be columnar with respect to the top and bottom electrodes, and that the crystal plane orientation be a (001) plane orientation of the tetragonal system or a (111) plane orientation of the rhombohedral system. A (100) plane orientation is also acceptable." (Column 3, lines 35-40). Thus, Sumi provides the advantages of low residual strain, excellent displacement when an electric field is applied, and increased ink ejection volume.

However, Sumi et al. does not teach a 3 layer substrate comprising a zirconium oxide layer formed on the passage-forming substrate; a cerium oxide layer formed on said zirconium oxide layer; and a superconductor layer formed on said cerium oxide layer and composed of an yttrium-barium-copper-oxygen-based material (YBCO) to achieve the desired crystal plane orientation. Further, there is no motivation or suggestion to provide such support structure for a piezoelectric element.

United States patent number 6,537,689 to Schoop et al., teaches multi-layer superconductors having buffer layers with oriented termination planes. The

superconductor articles contain a zirconium oxide layer, a cerium oxide layer and an YBCO layer, and exhibit relatively high critical current densities. "Another potential advantage of the invention is that it can provide a multi-layer article (e.g., a multi-layer superconductor), as well as methods of making such a multi-layer article, having a buffer layer and/or a superconductor layer with a high quality surface. For example, the surface can be relatively atomically flat (e.g., as measured by atomic force microscopy) and/or have an external plane with a relatively high amount of a desired orientation" (Column 4, lines 50-62). However, there is no motivation to use the superconductors of Schoop et al. to support a piezoelectric element.

United States patent number 6,617,283 to Paranthaman et al. teaches a method of depositing an electrically conductive oxide buffer layer on a textured substrate and articles formed therefrom. These substrates contain a zirconium oxide layer, a cerium oxide layer and an YBCO layer which "includes a substrate having a textured metal surface, a single lanthanum metal oxide epitaxial buffer layer disposed on and in contact with a surface of the substrate, and an electromagnetically active layer disposed on and in contact with the single epitaxial buffer layer" (Column 3, lines 23-27). However, there is no motivation to use the structures of Paranthaman et al. to support a piezoelectric element.

Internet reference titled "Complex Oxides Materials for Advanced Devices" teaches using high temperature superconductivity films as the template for epitaxially growing high quality ferroelectric films. The high temperature superconductivity layer can be used as an electrode giving advantages, even at room temperature. This

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reference also teaches that it is known to form the ferroelectric and high temperature superconductivity films (YBCO) on oxide buffer layers. These buffer layers are analogous to the zirconium oxide and cerium oxide layers in the claimed invention. However, this reference fails to teach or provide an electrode layer on the YBCO layer as required by the present invention.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Geoffrey Mruk whose telephone number is (571) 272-2810. The examiner can normally be reached on 7am - 330pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Meier can be reached on (571) 272-2149. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

GSM
10/25/2004

Michael S. Burke
Primary Examiner